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Psychosocial Risk Factors for Upper Respiratory Infection: PERSONALITY PREDICTORS OF URI DURING BASIC TRAINING*

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SUMMARY

Upper respiratory infections are common in Navy and Marine Corps personnel. The direct costs associated with these illnesses are substantial, and knowledge about susceptibility to URIs may provide information regarding general susceptibility to infectious disease. A risk profile for upper respiratory infections, therefore, may help develop methods for predicting and controlling the influence of infectious diseases in general, and upper respiratory infections in particular, in Navy and Marine Corps personnel.

Personality variables, particularly neuroticism and introversion, have been linked to greater risk of URI and/or more severe URI. The relationship between personality and URI in Navy basic training, therefore, was studied to determine the following: (a) Would the past evidence of associations between URI and neuroticism and introversion generalize to Navy basic training? (b) Would other established dimensions of personality, including openness to experience, agreeableness, and conscientiousness also predict URI? (c) Can URI be predicted with greater precision by measuring specific personality attributes rather than general personality dimensions? For example, would depression predict URI better than neuroticism? (d) Do combinations of personality characteristics predict URI better than individual personality characteristics? For example, is URI stronger among individuals who are both introverted and neurotic? (e) Are personality-URI relationships particularly pronounced among individuals with a history of susceptibility to infections and URI?

Two samples of Navy recruit volunteers completed personality and health history measures at the beginning of basic training; a third sample completed only the personality measures. Symptom check lists were completed weekly during training to assess URI and the general tendency to endorse all types of health symptoms. The NEO Personality Inventory provided measures of the five major dimensions alluded to above and a number of pertinent specific facets of personality (e.g., anxiety, depression, stress vulnerability). Health history and symptom reports were measured by scales developed earlier in this program. Analysis procedures included bivariate and partial correlation, moderated multiple regression, and one- and two-way analyses of variance.

Recruits with high scores on Neuroticism (average r = .165), Depression (average r = .151), and Anxiety (average r = .141) reported more symptoms. No other personality measure was a reliable correlate of URI. Combinations of personality factors did not improve the prediction, and associations were not more pronounced among recruits with a history of illness susceptibility. Controlling for general symptom reporting tendencies substantially reduced the correlations (Neuroticism, r = .111; Depression, r = .096; Anxiety, r = .096).

Despite the weak associations, the findings suggest that personality traits should be a component of psychobiological models of susceptibility to infections. This inclusion is appropriate if it is recognized that personality traits are only one factor contributing to specific situational perceptions and moods that presumably are the immediate determinants of acute susceptibility to infection. Over the long run across a number of settings, weak situational effects of personality traits can cumulate to substantial general health differences. The fact that anxiety and depression were the key personality variables provides some support for this model because these traits should be strongly related to situational anxiety and depressive states, both of which have been linked to immunological status and illness. Thus, there is reason to believe that the requirement of associations to acute psychological and biological reactions will be met. Specific tests of the assumptions underlying the proposed psychobiological model will be tested in subsequent studies.

INTRODUCTION

Personality may be a risk factor for upper respiratory illness (URI). Associations between personality and URI have been demonstrated in controlled studies of inoculation with live viruses (Totman, Kiff, Reed & Craig, 1980; Broadbent, Broadbent, Phillpotts & Wallace, 1984) and in field studies of naturally-occurring URI (Voors, Rytel, Jenkins, Pierce, & Stewart, 1969; Jacobs, Spilken, Norman & Anderson, 1970; Graham, Douglas & Ryan, 1986; Costa & McCrae, 1987). These associations could form part of a psychobiological model for susceptibility to infectious disease, but the reported correlations typically fall in the .15 to .30 range with smaller correlations occasionally reported (Vickers, Hervig & Edwards, 1986) or implied by nonsignificant results in studies with large samples (Jackson, et al., 1960; Rose, Jenkins & Hurst, 1978). On the whole, the typical URI-personality correlation probably is on the order of .10 to .20, the lower half of the range of correlations that Cohen (1969) has described as "small" for social science research. The present study explored several possible limitations of prior research to determine whether the weak associations represent the upper limit of URI-personality correlations to provide a better understanding of the potential for personallity traits as components of a psychobiological model of susceptibility to infectious disease.

One limitation of prior research was the omission of potentially important elements of personality. The studies cited above emphasized measures of neuroticism, a general personality dimension which includes the tendency to experience negative emotions and to react strongly to stresses (Watson & Clark, 1984; Costa & McCrae, 1985). Introversion, a second general personality dimension linked to a preference for avoiding social settings and a tendency to report few positive emotions, has been linked to higher susceptibility to URI in two studies of viral inoculation (Totman, et al., 1980; Broadbent, et al., 1984). This introversion finding apparently was not replicated in an independent series of laboratory studies (Jackson, et al., 1960) or in a field study of naturally-occurring colds (Rose, et al., 1978), even though both included personality inventories with measures that can be interpreted as indicators of introversion.

The prior emphasis on neuroticism and introversion means that three robust general dimensions of personality identified in current measurement

models (Norman, 1963; Goldberg, 1981; Digman & Takemoto-Chock, 1981) have received limited attention in prior studies. The additional dimensions, openness to experience, conscientiousness and agreeableness, may represent significant omissions given that terms, such as inhibited, perfectionist and conforming, have been used to describe individuals with autoimmune disease (Solomon & Moos, 1965). If immunological dysfunctions related to autoimmune diseases also affect resistance to infection, these additional personality attributes may be predictors of URI. The empirical case for connections between autoimmune disease and personality may be questionable and the complexity of the immune system makes it risky to generalize from one immunologically-mediated disease to another, but these prior findings still are reason to consider the additional personality dimensions as potential elements for a multivariate predictive equation for URI which could improve on the univariate predictions obtained for neuroticism and introversion.

Another possible reason for weak personality-URI associations in prior studies has been the reliance on complex personality measures. The typical measure in these studies has been complex in the sense that it combines a number of more basic, specific personality attributes into a general dimension or into a criterion-referenced scale. Eysenck's scales for extraversion and neuroticism used by Totman, et al. (1980) and Broadbent, et al. (1984) are examples of employing general, higher order personality dimensions. The use of scales designed to discriminate clinically ill individuals from healthy individuals (Voors, et al., 1969) or to discriminate between people with differing levels of academic or professional achievement (e.g., Rose, et al., 1978) represent instances of criterion-referenced scales. Both types of scale encompass a number of specific personality attributes (Nunnally, 1978; Cook, 1984; Costa & McCrae, 1985; Cattell, Eber & Tatsuoka, 1970). Weak associations between such scales and URI may have occurred because only one or two of the specific personality attributes assessed by a scale were related to URI. For example, when a general measure of neuroticism is employed, depression and anxiety, established correlates of URI (Voors, et al., 1969; Jacobs, et al., 1970), are combined with hostility and other attributes which may not be related to immunosuppression or immunologically-mediated illness. The present paper includes an attempt to isolate the "active ingredients" of the general personality dimensions in terms of relationships to URI.

Failure to consider interactions among personality characteristics is a third limitation of prior research. For example, URI may occur with exceptional frequency or severity when introverted and neurotic tendencies occur in combination. This possibility is suggested by prior evidence linking depression to URI and immune function, because depression may be particularly characteristic of introverted neurotics (Tellegen, 1985) even though it generally is subsumed under the heading of "neuroticism". Although this example deals with a single interaction, it illustrates the principle that interactions between personality attributes may be important. Hypotheses for other combinations of personality variables could be generated, but the approach in this study is an exploratory investigation of a range of personality interactions to determine whether there is any empirical basis to justify development and testing of interactive models in further research.

Another potential limitation of prior studies has been the failure to consider a general psychobiological formulation of disease (Weiner, 1977). In this formulation, psychosocial variables are related to the occurrence of a disease only among individuals with a biological predisposition for that disease. Biological predispositions for URI evidently exist (Reynolds, 1985), so a psychobiological formulation may apply to URI. This possibility is explored in this paper by using health history measures as indicators of biological predispositions to URI.

The issues outlined above were addressed in two studies involving three samples of U.S. Navy recruits going through basic training. This setting presents significant adaptational challenges (Zurcher, 1968) under relatively standardized living and working conditions. Basic training also involves a high rate of respiratory infections (Edwards & Rosenbaum, 1971; Pazzaglia & Pasternak, 1982). The combination of challenges, standardized living conditions, and exposure to pathogens should help eliminate background differences which could obscure URI-personality relationships in settings where background factors are more variable (Golding, 1975). Thus, basic training should be a good setting to isolate the personality correlates of URI if there are any.

STUDY 1

Method

Sample

Two samples of recruits who began training in July and August, 1986, were studied. The demographic characteristics of these samples are described in Table 1. The two samples did not differ significantly with regard to age, ethnicity or education.

Table 1

Demographic Characteristics of the Samples

	Sample A	Sample B
N =	552	591
Age		
Mean	19.51	19.31
S.D.	2.86	2.63
Range	16-33	17-33
Ethnicity		
Hispanic	7%	7%
Black	16%	17%
White	71%	70%
Other	6%	5%
Education		
No Diploma	5%	3%
G.E.D.[a]	3%	2%
H.S. Diploma	92%	95%

[a]G.E.D. = Graduate Equivalence Diploma

Personality Measures

The NEO Personality Inventory (Costa & McCrae, 1985) was chosen to measure personality because it is designed specifically to measure the five robust dimensions of personality. This breadth of coverage within the confines of a well-defined sampling schema was critical given the present concern with identifying elements of personality that may not have been adequately represented in prior work.

The five major dimensions measured by the NEO Personality Inventory are

Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness. High Neuroticism scores identify individuals who are " . . . prone to psychological distress, unrealistic ideas, excessive cravings or urges, and maladaptive coping responses." Extraversion scores indicate " . . . quantity and intensity of interpersonal interaction, activity level, need for stimulation, and capacity for joy." Openness scores indicate " . . . seeking and appreciation of experience for its own sake; toleration for and exploration of the unfamiliar." Agreeableness scores indicate " . . . the quality of one's interpersonal orientation along a continuum from compassion to antagonism in thoughts, feelings and actions." Conscientiousness scores indicate " . . . the individual's degree of organization, persistence, and motivation in goal-directed behavior." Definitions of the specific facets of Neuroticism, Extraversion and Openness are the most extensively developed of these measures, and each of these general dimensions is assessed by 48 items which also can be scored for 6 8-item scales representing specific facets of the general dimension. The Conscientiousness and Agreeableness dimensions are 18-item composites which currently are not scored for specific subscales. Details regarding the general dimension scales and the facet composites are given in Costa and McCrae (1985); brief definitions of the pertinent facets will be given in the presentation of results where necessary to understand significant associations.

The NEO Personality Inventory also satisfied several important secondary criteria for the choice of personality measures. There is evidence of convergent and discriminant validity of the five major dimensions when self-reports are compared to peer ratings (McCrae & Costa, 1987). High correlations to other established measures of the major personality dimensions have been demonstrated (McCrae & Costa, 1985). Brief measures of specific personality attributes that prior research has implicated as possible correlates of URI and/or immunosuppression (e.g., depression, anxiety, assertiveness) are included. Inventory construction explicitly excluded items dealing with physical symptoms, so the scales will not be confounded with health criteria. Finally, major possible sources of response bias have been controlled. Items which are keyed positively and negatively are present in approximately equal numbers in each scale, thereby controlling for acquiescence bias. In addition, scale scores have been shown to be only slightly related to scores on social desirability measures.

Health History Measures

The Typical Cold Severity and History of Infectious Disease scales developed by Vickers and Hervig (1988b) were used to assess health history. The development study for these scales also demonstrated that they were adequate to represent a set of 7 health history measures for the purpose of predicting URI in basic training. Also, principle components analyses, conducted as an aid to selecting a set of nonredundant health history measures for use in this study, indicated that the full set of health history measures comprised two factors. Typical Cold Severity had the highest loading on one factor and History of Infectious Disease on the other. Therefore, these two health history scales were judged adequate to represent health history for the present analyses.

Typical Cold Severity is a 10-item scale asking about the severity of specific symptoms when the person has had colds in the past. History of Infectious Diseases is a 26-item scale asking whether the person has had the following illnesses: (a) scarlet fever, (b) diphtheria, (c) shingles, (d) chicken pox, (e) mumps, (f) small pox, (g) German or 3-day measles, (h) pneumonia, (i) polio, (j) meningitis, (k) red measles, (l) appendicitis, (m) tonsillitis, (n) serious or recurrent ear infections, (o) serious or recurrent eye infections, (p) serious or recurrent urinary tract infections (non-venereal), (q) abscessed teeth or gums, (r) recurrent sore throat, (s) recurrent boils, (t) encephalitis, (u) hepatitis (jaundice), (v) dysentery, (w) infectious mononucleosis, (x) warts, (y) whooping cough, and (z) bronchitis.

Health Assessment

Symptom reports were used to assess health status because these reports are known to correlate with clinical ratings of illness (Roden, 1958; Totman, Reed & Craig, 1977), viral shedding (Forsyth, Bloom, Johnson & Chanock, 1963; Totman, et al., 1980), and biochemical indicators related to infection (Lytle & McNamara, 1967; Lytle, Rytel & Edwards, 1966; Naclerio, et al., 1988). The correlations in the studies just cited typically have been on the order of .50 to .90. Symptom reports also have the advantage of providing a more complete assessment of illness in basic training than would be obtained from alternative measures, such as outpatient treatment records, because many recruits who are ill do not seek medical care.

Symptom checklists were completed at seven data collection sessions.

These sessions were conducted 4, 12, 19, 26, 37, 46, and 53 days after beginning training for approximately 50% of the participants. The sessions were conducted two days later for the remaining participants, because a weekend intervened between the start of the study and the fourth day of the training schedule for these participants. This schedule was the closest possible approximation to a weekly assessment within the constraints of the training schedule.

At each session recruits indicated the severity of each symptom over the preceding three days of basic training by marking the appropriate space on an optical scanning sheet with response options ranging from "Not at All Severe" (1) to "Extremely Severe" (5). URI was assessed by an 8-item composite of the responses to questions asking about fever, sore throat, dry cough, productive cough, stuffed-up nose, sneezing, hoarseness, and sinus pain. Raw scores were adjusted for the influence of concurrent allergies and musculoskeletal illnesses (cf., Vickers and Hervig (1988a)).

Cumulative URI scores were computed for early and late portions of training. The early URI scores were the average for responses obtained during sessions 2 through 4. The late URI scores were the average for sessions 5 through 7. Session 1 scores were not used in these computations because of concerns that this session yielded invalid scores (cf., Vickers & Hervig, 1988a). Separate scores for early and late URI were computed because scheduling conflicts caused many recruits to miss one or more data collection sessions. This problem was particularly acute after the first month of training, because the recruits most likely to be absent during the later testing sessions were those with above average scores on intelligence tests and/or with positions of leadership in their training companies. Therefore, it was evident that analyses limited to participants with complete data for all six test sessions could provide results which were not representative of the overall population.

A General Symptom Reporting composite was constructed from responses to items concerning skin irritation, vomiting, diarrhea and trouble hearing. This composite consisted of relatively infrequent symptoms which, with the possible exception of vomiting and diarrhea, did not appear to represent any common illness syndrome in basic training. Vomiting and diarrhea no doubt co-occur in some illnesses, such as infections of the gastrointestinal tract, but these two symptoms are infrequent in conjunction with infections

in military and civilian populations (Forsyth, et al., 1963; Gwaltney, Hendley, Simon & Jordan, 1967) and were weakly related empirically in the recruit samples studied. In fact, both symptoms were more strongly related to trouble hearing than to each other. Given the generally low frequency of occurrence and the relative independence of the four symptoms, it seemed reasonable to assume that high scores would occur only among individuals who had a strong tendency to report symptoms.

Analysis Procedures

Exploratory analyses split the samples into deciles based on the NEO score distributions and used the 10 resulting groups as the classification bases for one-way analyses of variance. These analyses included tests for curvilinear trend components and gave special attention to the possibility that the extreme groups would have exceptionally high rates of URI. The latter point was important, because either extreme of a normal personality dimension could imply behavioral rigidity which would limit the person's ability to adapt to situational demands (cf., Costa & McCrae, 1985). The consequences of such limitations might include increased psychosomatic illness, including URI secondary to immunosuppression under stress. There was no evidence of curvilinearity or of notable elevations in URI at the extremes of the dimensions. Similar conclusions had been reached regarding health history and URI in an earlier study (Vickers & Hervig, 1988b). Thus, the following analyses assumed linear associations between the predictors and health status.

Results reported below include Pearson product moment correlations, multiple regression analyses, including some cross-product analyses to test for interactions (Cohen, 1978), and analyses of covariance to test for parallelism of within-group regression lines. Procedural details are described in the presentation of the results. All analyses were performed with the SPSS^{X} statistical package (SPSS, 1983).

Effects which accounted for at least 1% of the criterion variance in each sample were accepted as statistically significant. Results have been reported to the third decimal place (e.g., $r = .211$), even though the data quality probably does not justify this level of precision. This approach does, however, avoid confusion in cases where rounding values to the second decimal point would result in a correlation of less than .10 being tabled as .10. This difference, in some instances, would result in the appearance of

an association consistently equalling or exceeding .10 when, in fact, this was not the case. Where appropriate, combined significance estimates for effects meeting the effects size criterion have been estimated by the methods of adding probabilities and adding weighted z-scores (Rosenthal, 1978). The pooled significance levels reported in the text are those obtained by the method of adding probabilities.

Results

Personality-illness correlations were uniformly slight (Table 2). Only Neuroticism and its facets of Anxiety and Depression produced correlations as large as r = .10 in both samples. The specific NEO Neuroticism facets of Anxiety, a measure of tension and worrying as opposed to calm relaxation, and Depression, a measure of hopelessness and downheartedness as opposed to hopefulness and feeling worthwhile, were related to higher URI rates early in training. The specific NEO Extraversion facets of Gregariousness, a measure of having many friends and liking social contact as opposed to being solitary, self-contained, and avoiding crowds; and Assertiveness, a measure of being dominant and confident as opposed to being unassuming and retiring, were related to lower URI scores late in training. Given the sample size differences between early and late in training, it was possible that the differences in patterns for these time periods were the result of selective losses of participants. Analyses of covariance were conducted to test this possibility. In these analyses, early URI was the dependent variable and personality variables were the covariates. Group classification was based on having (a) both early and late URI scores or (b) early URI score only. The analyses tested for differences between the two groups in the form of nonparallel regression lines for personality with early URI. None of these analyses produced associations which even approached statistical significance.

Table 2

Correlations Between Personality Scales and Respiratory Illness Scales

	Early URI		Late URI		Infectious Disease History		Typical Cold	
Sample:	A	B	A	B	A	B	A	B
Neuroticism	.155	.126	.167	.072	.188	.160	.319	.357
Anxiety	.132	.103	.101	.035	.152	.134	.291	.308
Hostility	.079	.098	.096	.022	.096	.071	.158	.136
Depression	.129	.137	.088	.075	.145	.201	.270	.328
Self-Consciousness	.063	.096	.200	.093	.134	.102	.239	.239
Impulsiveness	.164	.065	.168	.017	.151	.137	.226	.276
Stress Vulnerability	.099	.029	.112	.047	.152	.045	.224	.269
Extraversion	.026	.023	-.073	-.123	-.052	-.011	-.075	-.040
Warmth	-.019	.018	-.066	-.077	-.059	.013	-.037	.038
Gregariousness	.010	-.030	-.107	-.132	-.070	-.066	-.084	-.048
Assertiveness	-.060	-.043	-.112	-.157	-.040	-.056	-.125	-.158
Active	-.049	.063	.004	.088	-.028	-.027	-.071	-.087
Excitement	.076	.077	-.042	-.083	-.039	.096	.021	.089
Positive Emotion	.130	.023	.080	-.076	.033	.009	.014	.039
Openness	.070	.058	.070	.019	-.025	.045	.082	.001
Fantasy	.053	.094	.093	-.038	.024	.061	.131	.071
Aesthetics	.055	.017	.091	-.066	-.018	-.016	.041	-.038
Feelings	.066	.085	.027	-.059	-.048	.085	.118	.119
Actions	.046	.008	-.013	.115	.014	-.018	-.026	-.074
Ideas	.009	-.021	-.068	.081	-.044	.012	-.035	-.061
Values	.041	.042	.098	.077	.016	.040	.056	.004
Conscientiousness	-.176	.001	-.086	-.068	-.166	-.087	-.181	-.166
Agreeableness	-.034	-.013	.014	.043	-.093	-.022	-.064	-.051
Sample Size:								
Maximum n =	341	362	221	194	516	537	512	520
Minimum n =	339	360	220	194	511	533	507	516

NOTE: Correlations exceeding Cohen's (1969) criterion for a small effect size (absolute r > .099) in both samples have been underlined.

Effects of General Symptom Reporting

URI and General Symptom Reporting were strongly correlated in both samples (Sample A, r = .470; Sample B, r = .489), so associations between personality and General Symptom Reporting tendencies may have inflated the correlations in Table 2. The possibility that personality variables were related only to differences in an overall symptom reporting tendency was tested by computing partial correlations between personality and URI controlling for General Symptom Reporting.

None of the partial correlations between personality and URI controlling for General Symptom Reporting were greater than .10 (absolute) in both samples (Table 3). In fact, only Neuroticism, Anxiety, and Depression produced partial correlations as large as .10 in either sample. The sample differences in partial correlations were attributable to the fact that General Symptom Reporting was a moderately strong correlate of personality in Sample A, but not in Sample B (Appendix A).[1]

Table 3

Partial Correlations: Personality Scales with Upper Respiratory Illness Scales Controlling for General Symptom Reporting

	Early URI		Late URI	
Sample:	A	B	A	B
Neuroticism	.042	.142	.102	.073
Anxiety	.030	.125	.051	.066
Depression	.044	.106	.044	.078
Gregariousness	.098	-.047	-.047	.080
Assertiveness	.017	-.031	-.037	.183

NOTE: Only scales with at least one replicable (r > .099 (absolute)) zero-order correlation included. The partial correlations associated with those zero-order associations have been underlined. The General Symptom Reporting score partialed out of each zero-order correlation was that corresponding to the time period of the URI measure.

[1]Additional analyses tested the possibility that training company differences in URI rates affected personality-URI relationships. For example, if different pathogens were epidemic in different companies, differences might arise which would affect the probability and severity of URI and would tend to obscure URI-personality associations by introducing a source of variance in URI that was independent of personality.

Interaction Models for URI During Basic Training

Interactions Between Personality Dimensions. The hypothesis that interactions among personality characteristics would be important predictors of URI was tested by analyses combining all possible pairs of the 5 major dimensions of the NEO Personality Inventory. The analysis initially was limited to the 5 major dimensions with the intent of following up any suggestive findings by analyzing interactions between facets of the pertinent dimensions.

Tests for interactions included moderated multiple regressions with cross-products of the predictors representing the interaction term (Cohen, 1978) and two-way analyses of variance with subjects grouped approximately into quintiles based on personality score distributions. The ANOVA procedures were included as an exploratory alternative to the regression analyses. This alternative was necessary as the regression analyses are most sensitive to interactions in which the association between one predictor and the criterion changes at a constant rate as the value of the second predictor. It did not seem reasonable to assume that this type of interaction was the only possibility.

Only 1 of the 40 moderated regression analyses (2 samples by 2 time periods (i.e., Early and Late) by 10 pairs of personality dimensions) produced a significant interaction term and even this finding was barely significant ($p = .049$). Only two of the 40 two-way ANOVAs produced significant ($p < .05$) interactions, but both interactions failed to replicate ($p > .32$). Also, the moderated regression analysis did not pro-

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One-way ANOVAs with company membership as the group classification variable showed significant company differences for early URI ($F(7,368) = 4.27$, $p < .001$), but not late URI ($F(6,249) = 0.28$, $p < .945$), in Sample A. Neither difference was significant in Sample B for early ($F(7,420) = 0.95$, $p > .467$) or late URI ($F(6,216) = 1.55$, $p > .163$). In Sample A, the Bartlett-Box F test for homogeneity of variance was nonsignificant for early URI ($F =$, $p > .297$), but not late URI ($F =$, $p < .026$); comparable Sample B figures were ($p > .181$) and ($p > .052$). To test the possibility that even the minor differences noted were important, adjusted URI scores which subtracted his company's average score from each individual's observed score; a second adjusted URI score divided the first adjusted score by the standard deviation of the scores for that company. Correlations between these adjusted scores and the NEO scales differed trivially from the correlations to the raw scores.

duce any evidence of associations that were weak, but reliable across the two samples (pooled $p > .12$ for all tests). The only evidence for a reliable, statistically significant interaction was that for the two-way ANOVA for Extraversion and Openness (Study A, $p < .14$; Study B, $p < .10$; pooled $p < .026$). Tests of simple main effects (Winer, 1962) indicated significant group differences only for the highest quintile of Openness (pooled $p < .048$). Trend analyses showed a significant linear trend URI-Extraversion associations in the high Openness quintile in Study A ($p < .04$) and a marginally significant linear trend in Study B ($p < .10$; pooled significance, $p < .009$). Note that this single reliable interaction is a modest return in the context of 200 (i.e., 10 interactions each with 4 trend components for 5 levels of the control variable) implied tests for individual trends.

Health History as a Moderator. The hypothesis that personality would predict URI primarily among individuals with a history of infectious disease or severe colds was tested by multivariate analysis of covariance (MANCOVA). The samples were divided into quintiles, as nearly as possible, based on health history scores. These quintiles were the grouping variables for MANCOVA procedures with URI the dependent variable and the five major NEO personality dimensions as covariates. Tests for parallelism of regression lines determined how much fitting group-specific regression coefficients for the covariates improved the prediction of URI (cf., Tatsuoka, 1971). Separate MANCOVAs were conducted with Infectious Disease History and Typical Cold as the classification variables. The largest F-value for any of the four parallelism tests (2 classification variables for 2 samples) was 1.16 ($p > .285$); the lowest pooled significance estimate was $p < .34$.

Personality Interactions and Health History Variables

Given the relatively large personality-health history associations (cf., Table 2), it was possible that the interaction hypotheses regarding personality interactions would receive more support if health history measures were regarded as indicators of cumulative health trends and treated as a criterion to be predicted. This possibility was tested by repeating the URI-personality interaction analyses with Infectious Disease History and Typical Cold as the dependent variables.

Moderated regression did not identify any significant moderator effects. Only 1 of 40 cross-product terms was significant (Neuroticism-

Openness for Typical Cold, $p < .025$ in Sample A), and the association clearly failed to replicate ($p < .48$ in Sample B). The cross-product term for Openness and Conscientiousness produced a weak, but reliable, association to Typical Cold (Sample A, $p < .06$; Sample B, $p < .17$; pooled $p < .027$), but the interaction accounted for less than 0.5% of the variance in Typical Cold in each sample.

The two-way ANOVAs produced statistically significant interactions for Typical Cold when Conscientiousness was paired with Extraversion or Agreeableness (Appendix B). The simple main effects were significant ($p < .05$) for the third and fourth quintiles of Conscientiousness when Extraversion was the control variable. However, none of the trend analyses associated with these simple main effects was statistically significant (pooled $p > .07$ for each test). Therefore, the overall interaction did not involve any reliable effects.

The simple main effects for Agreeableness were significant for the fourth and fifth quintiles of Conscientiousness (pooled significance, $p < .007$, for each). In the fourth quintile of Conscientiousness, the cubic (pooled significance, $p < .026$) and quartic trends (pooled significance, $p < .005$) explained a weighted average of 1.8% and 3.3% of the within quintile variance. In the fifth quintile, the quartic trend (pooled significance, $p < .023$) explained an average of 2.7% of the variance. If each quintile accounted for 20% of the variance in Typical Cold scores, these reliable trends would account for approximately 1.8% (i.e., (1.8+3.3+2.7)*.20) of the total sample variance for Typical Cold.

STUDY 2

The findings from Study 1 indicated that some aspects of neuroticism were reliable bivariate correlates of URI, but controlling for General Symptom Reporting produced partial correlations that were markedly different in the two samples. In one case, the partial correlations were large enough to be of interest, while in the other these correlations were virtually zero. Given only two samples, there was no way to decide which result better represented the population associations, so the same research design was applied to a third sample of recruits to obtain further information about the magnitude of the URI-personality partial correlations.

Results

The demographic characteristics of the third sample were generally comparable to those of the first two samples. The typical recruit in this sample (n = 494) was 19.3 years of age (S.D. = 2.5; range = 17-33) and had a high school diploma (90%) or Graduate Equivalency Diploma (5%). The majority of these recruits were of White ethnicity (69%) with Blacks (15%) and Hispanics (8%) the largest minority groups.

The bivariate correlations between early URI and neuroticism indicators were slightly stronger in this study sample than in the two prior samples (Table 4). The associations between Gregariousness and Assertiveness and lower scores on late URI noted in the earlier samples failed to replicate. All partial correlations between early URI and neuroticism indicators controlling for General Symptom reporting were .10 or greater. The Extraversion-Openness interaction previously noted for early URI failed to replicate ($p < .44$). No additional bivariate or partial correlations of importance were identified (Appendix C).

Table 4

Correlations Between Personality Scales and Illness Scales: Study 2

	URI		GSR		Partial Correlations Controlling GSR	
	Early	Late	Early	Late	Early	Late
Neuroticism	.213	.076	.187	.274	.146	-.045
Anxiety	.190	-.004	.161	.194	.133	-.096
Hostility	.124	.059	.099	.208	.090	-.033
Depression	.185	.069	.129	.243	.143	-.039
Self-Consciousness	.171	.098	.175	.193	.104	.019
Impulsiveness	.100	.126	.114	.114	.054	.086
Stress Vulnerability	.179	.002	.170	.236	.116	-.111
Gregariousness	-.039	.060	.053	-.067	-.070	.097
Assertiveness	-.050	.100	-.027	.003	-.042	.108
Sample Size:						
Maximum n =	323	222	329	230	320	219
Minimum n =	320	220	326	228	317	217

DISCUSSION

These studies added to the evidence that correlations between URI and neuroticism correlations are in the .10 to .20 range and demonstrated that controlling for general symptom reporting tendencies suggested the true association between personality and illness is probably closer to .10 than to .20. The search for additional personality predictors of URI and for interactions among personality variables or between personality and biological predisposition to illness did not provide any reliable evidence of associations that would replace the bivariate neuroticism correlations with more complex multivariate equations. In fact, the only possible lead toward improving the prediction of URI was the evidence that Anxiety and Depression, two specific facets of Neuroticism, predicted URI as well as the general dimension. This finding may be encouraging, because the scales measuring these two constructs were quite brief. More extensive assessments of these constructs might improve the prediction of URI, but the gains that can be expected are limited as the scales already possess moderate reliability (Costa & McCrae, 1985). Even if these scales were extended to provide perfect assessment of individual differences in anxiety and depression, the resulting personality-URI correlations would not exceed what appears to be a .20 ceiling.

The weak associations between personality and URI in basic training directed attention to the possibility that a temporal mismatch between the criterion and the predictor variables was influencing the findings. In particular, a measure of illness occurring over a brief time period in a specific setting might underestimate the relationship between personality and URI. More substantial associations might be expected with measures that aggregate across a broader sampling of time and situations (Epstein, 1979). This possibility was tested in the Study 1 samples by relating personality to URI history and general history of infectious diseases. The analysis results indicated that the estimated strength of associations would have been greater and that some reliable interactions might be identified if retrospective health history had been the criterion variable. Overall, personality might explain as much as 10 to 12 per cent of the variance in health history measures.

One interpretation of personality-health history findings would be that personality is a weak predictor of URI in a specific time and place, but a

stronger predictor of long-term health trends. Such an increment in personality-criterion associations is common when the criterion is aggregated over longer time periods (Epstein, 1979). The prospective findings during basic training offer some support for this interpretation, but the difference between the correlations obtained for URI during basic training and those for health history still could arise from the other alternatives. In particular, the retrospective character of the health history measures allows for the possibility that the health history correlations reflect an influence of health during childhood on neuroticism or an influence of neuroticism on the recall of past illness.

Considering the full set of findings under the assumption that the URI-health history associations indicate the cumulation of prospective effects of personality over time, it is possible to formulate a model in which enduring personality traits are viewed as risk factors influencing acute, situation-specific psychological reactions that are proximal determinants of immunosuppression and illness (Thoits, 1984). Such models imply weak associations between personality traits and URI when observations are limited to a single setting observed over a short time period. In such cases, the effect of personality on URI is bounded by two considerations. First, factors other than personality no doubt act to determine both psychological and biological reactions, a point which implies that personality traits will be moderate predictors of situational reactions (Golding, 1975). Second, personality traits may be indirectly linked to immunological processes that are the immediate determinants of susceptibility to infection. Based on these considerations, personality traits have effects on URI that depend on several intermediate steps, each of which will be imperfect (Rahe & Arthur, 1978). Standard path analytic statistical models show that under such circumstances the bivariate correlation between URI and personality will be the product of two or more numbers, each of which is less than 1.00 (Heise, 1975, pp. 52-55).

Given the proposed psychobiological model sketched above, measures of acute psychological reactions and immunological status must be added to the equation for URI to fully evaluate the importance of personality. The acute reactions should be relatively strong correlates of URI and should be partly determined by the personality traits. Evidence that anxiety and depression are related to immune function provides some support for this position

(Heisel, Locke, Krause & Williams, 1986; Irwin, Daniels, Bloom & Weiner, 1986; Irwin, Daniels, Bloom Smith, & Weiner, 1987; Irwin, Daniels, Smith, Bloom & Weiner, 1987; Kiecolt-Glaser, et al., 1984; Kiecolt-Glaser, et al., 1987; Locke, et al., 1984). Personality is stable over time, so it is reasonable to assume that the processes observed in a specific setting are repeated in different specific situations at different times. The result is that the poorly predicted illness outcomes arising from specific situational reactions cumulate over time. The actuarial effect of this cumulation will be the production of a stronger association between personality and health as the effects of specific situations presumably will average out over the long run. From this perspective, the combined pattern of associations between personality and URI during basic training and between personality and history of URI and infectious disease implies personality traits can be a reasonable component of a long-term risk factor equation for susceptibility to infections. Therefore, it is important to further assess the theoretical assertions and the associated asssumptions just outlined.

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Appendix A

Correlations Between Personality Scales and General Symptom Reporting

	Early URI		Late URI	
Personality Scale	1	2	1	2
Neuroticism	.255	.041	.181	.002
Anxiety	.227	.034	.136	-.045
Hostility	.164	.007	.100	.071
Depression	.185	.118	.124	.030
Self-Consciousness	.174	.022	.197	.073
Impulsiveness	.204	-.004	.145	-.085
Stress Vulnerability	.143	-.019	.127	-.053
Extraversion	-.065	-.062	-.092	-.045
Warmth	-.061	-.067	-.014	-.087
Gregariousness	-.103	-.064	-.137	-.095
Assertiveness	-.139	-.057	-.158	.010
Active	.001	.040	-.054	.098
Excitement	.011	-.012	.005	.017
Positive Emotion	.038	-.052	.017	-.075
Openness	.024	.051	.093	.057
Fantasy	.038	.111	.186	.044
Aesthetics	.018	-.013	.032	.022
Feelings	.047	-.014	-.029	-.009
Actions	-.035	-.003	.008	-.033
Ideas	.015	.082	.058	.182
Values	.014	.010	.063	.031
Conscientiousness	-.100	.002	-.131	-.020
Agreeableness	-.013	-.034	.032	-.104

NOTE: Correlations exceeding Cohen's (1969) criterion for a small effect size (absolute r > .099) in both studies have been underlined.

Appendix B

Typical Cold: Prediction by Conscientiousness and Agreeableness

Sample A

Conscientiousness Quintile:	Agreeableness Quintile: 1	2	3	4	5	Simple Main Effect Sig.
1	2.92	2.64	2.46	2.70	2.74	.232
	(28)	(26)	(23)	(19)	(12)	
2	2.80	2.84	2.40	2.58	2.32	.147
	(23)	(23)	(27)	(13)	(10)	
3	2.31	2.63	2.77	2.38	2.80	.067
	(18)	(26)	(18)	(15)	(12)	
4	2.28	2.54	2.83	2.25	2.89	.018
	(13)	(29)	(30)	(19)	(16)	
5	2.13	2.62	2.39	2.36	2.10	.040
	(18)	(21)	(23)	(23)	(23)	

Grand Mean = 2.56, N = 508, F(Con) = 4.32 ($p < .003$), F(Agree) = 0.91 ($p < .459$), F(CxA) = 2.54 ($p < .002$), MS(residual) = .464

Sample B

Conscientiousness Quintile:	Agreeableness Quintile: 1	2	3	4	5	Simple Main Effect Sig.
1	2.60	2.90	2.41	2.51	2.86	.116
	(26)	(19)	(17)	(17)	(14)	
2	2.62	2.49	2.76	2.48	2.62	.699
	(18)	(28)	(20)	(12)	(12)	
3	2.72	2.34	2.53	2.39	2.50	.436
	(21)	(22)	(30)	(19)	(18)	
4	2.64	2.42	2.53	2.21	2.60	.096
	(16)	(13)	(24)	(26)	(24)	
5	1.88	2.91	2.23	2.38	2.32	.027
	(8)	(11)	(26)	(26)	(51)	

Grand Mean = 2.50, N = 518, F(Con) = 2.96 ($p < .021$), F(Agree) = 1.05 ($p < .383$), F(CxA) = 1.94 ($p < .005$), MS(residual) = .441

Appendix C

Correlations Between Personality Scales and Illness Scales: Study 2

	URI		General		Partial Correlations	
	Early	Late	Early	Late	Early	Late
Personality Scale						
Neuroticism	.213	.076	.187	.274	.146	-.045
Anxiety	.190	-.004	.161	.194	.133	-.096
Hostility	.124	.059	.099	.208	.090	-.033
Depression	.185	.069	.129	.243	.143	-.039
Self-Consciousness	.171	.098	.175	.193	.104	.019
Impulsiveness	.100	.126	.114	.114	.054	.086
Stress Vulnerability	.179	.002	.170	.236	.116	-.111
Extraversion	-.063	.115	.001	-.074	-.071	.162
Warmth	-.066	.070	-.033	-.056	-.057	.103
Gregariousness	-.039	.060	.053	-.067	-.070	.097
Assertiveness	-.050	.100	-.027	.003	-.042	.108
Active	-.057	.109	-.024	-.058	-.050	.147
Excitement	.018	.058	.029	-.080	.005	.101
Positive Emotion	-.069	.123	-.002	-.045	-.077	.157
Openness	.078	.062	-.019	-.023	.097	.079
Fantasy	.073	.051	.022	.010	.071	.051
Aesthetics	.053	.087	.019	.053	.050	.071
Feelings	.042	.126	-.019	.108	.057	.089
Actions	.070	.010	-.001	-.077	.079	.047
Ideas	.007	.012	-.048	-.111	.033	.066
Values	.062	-.099	-.063	-.084	.102	-.070
Conscientiousness	-.119	-.086	-.103	-.149	-.082	-.026
Agreeableness	-.049	-.037	-.041	-.069	-.034	-.009
Sample Size:						
Maximum n =	323	222	329	230	320	219
Minimum n =	320	220	326	228	317	217

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Neuroticism and introversion have been linked to greater susceptibility to infections. This study examined personality correlations of upper respiratory illness (URI) in three samples of Navy recruits during military basic training, a setting with standardized living and working conditions and high rates of URI. Neuroticism was related to URI (average r = .165) as were two of its component facets, Anxiety (average r = .141) and Depression (average r = .151). Introversion, Openness to Experience, Agreeableness, and Conscientiousness did not produce correlations reliably in excess of .100. A partial correlation analysis controlling for general symptom reporting tendencies produced much smaller associations (partial r = .111, .096, and .096, respectively). Interactions among personality attributes and between personality and health history variables did not improve the prediction of URI. Neuroticism and conscientiousness were stronger predictors of health history than of acute URI. The findings were consistent with a psychobiological model which asserts that personality is weakly related to acute illness because it is only

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19. (Continued) one of several factors that influence acute psychological states that are more immediate precursors of illness, but that personality is a stronger predictor of long-term health trends reflecting the cumulative effects of personality across a number of different situations. (S)